Master Seminar:
Machine Intelligence with Deep Learning

Introduction

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Internet Technologies and Systems
Hasso Plattner Institute, University of Potsdam
Content

- **Teaching team**
- Multimedia analysis and Deep Learning
- Topic presentation
- Important information
Personal Information

Christian Bartz, M.sc

- **Research background**
  - 2010~2013 Bachelor Degree (Hasso-Plattner-Institute)
  - 2013~2016 Master Degree (Hasso-Plattner-Institute)
  - 2016~ PhD Student at Hasso-Plattner-Institute

- **Research interests**
  - Computer vision, deep learning, text recognition
Personal Information

Joseph Bethge, M.sc

- Research background
  - 2010~2013 Bachelor Degree (Hasso-Plattner-Institute)
  - 2014~2017 Master Degree (Hasso-Plattner-Institute)
  - 2017~ PhD Student at Hasso-Plattner-Institute

- Research interests
  - Computer vision, deep learning, binary neural networks
Mina Rezaei, M.sc

- Research background
  - 2005.10-2008.03 Azad University, Arak, Iran
    B.S c. Computer Engineering
  - 2010.10-2013.03 Shiraz University, Shiraz, Iran
    M.Sc. Artificial Intelligence
  - 2015.11-now PhD student at HPI

- Research interests
  - Deep Learning for Medical Image Analysis
Dr. Haojin Yang

- Dipl.-Ing study at TU-Ilmenau (2002-2007)
- Software engineer (2008-2010)
- PhD student, internet technology and system HPI (2010-2013)
- Senior researcher, Multimedia and Deep Learning research team
- Research interest: multimedia analysis, computer vision, machine learning/deep learning
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Machine Intelligence with Deep Learning

Course Website
Nowadays text localization typically based on fully supervised object detectors.
How about a system that behaves like a human?
Text Localization with Deep Reinforcement Learning

- Plan:
  1. Learn about reinforcement learning
  2. Train agent for text localization
  3. ...
  4. Profit!
Binary Neural Networks

Data → High performance servers → Results (Latency)

- Power → CPU → Storage

processing in the cloud

processing on device
Binary Neural Networks

- Use BMXNet “2.0” based on MXNet Gluon API (Python)
  - Dynamic computational graph, easier debugging
  - Develop an application which requires: guaranteed low latency, data privacy and/or network independency
  - Specific application is open for discussion, we have a few ideas prepared
- Deploy on a mobile device, e.g. smartphone or Raspberry Pi
  - Convert model from full-precision to binary (probably Python)
  - Update code for optimized computation to BMXNet “2.0” (C++)

| Python (80 %) | C++ (20 %) |
Interpretable Deep Models
Mina Rezaei
15.10.2018
Motivation

- DL has achieved the best performance in many domains

Source: http://interpretable-ml.org/miccai2018tutorial/
Why interpretability?

- Verify that classifier works as we expected?
  - Wrong decisions can be costly and dangerous
- Understand weaknesses and improve classifier
- Learn new things from learning machine
- Interpretability in the sciences
Dimension of Interpretability

Different dimensions of “interpretability”

prediction
“Explain why a certain pattern $x$ has been classified in a certain way $f(x)$.”

model
“What would a pattern belonging to a certain category typically look like according to the model.”

data
“Which dimensions of the data are most relevant for the task.”

Source: http://interpretable-ml.org/miccai2018tutorial/
Techniques of Interpretability

**Mechanistic Understanding**

Understanding what mechanism the network uses to solve a problem or implement a function.

**Functional Understanding**

Understanding how the network relates the input to the output variables.

Source: http://interpretable-ml.org/miccai2018tutorial/
Techniques of Interpretability

Source: http://interpretable-ml.org/miccai2018tutorial/
“How does a goose typically look like according to the neural network?”

\[
\text{arg max}_{x} f(x) + \text{reg.}
\]
Decision Analysis

- Sensitivity Analysis
- Layer-wise Relevance Propagation (LRP)
  - Heatmap of prediction

Can we objectively measure which heatmap is best?

Source: http://interpretable-ml.org/miccai2018tutorial/
Model Analysis

Learn $P(x|y)$ and $P(y)$

Learn $P(y|x)$ indirectly

$P(y|x) \propto P(x|y)P(y)$

Generative Model ($G$)

Learn directly $P(y|x)$

Discriminative Model ($D$)
Model Analysis for Segmentation Task

**Generative Model**

- $\mathbb{K} \mathcal{L} [\mathcal{N}(\mu(X), \Sigma(X)) || \mathcal{N}(0, I)]$
- $\mathbb{K} \mathcal{L} [\mathcal{N}(\mu(X), \Sigma(X)) || \mathcal{N}(0, I)]$

- Sample $z$ from $\mathcal{N}(\mu(X), \Sigma(X))$

**Discriminative Model**

- $\|X - f(z)\|^2$
- $\|X - f(z)\|^2$

- Discriminative
- Generative

Input image tile

Output segmentation map

- conv 3x3, ReLU
- copy and crop
- max pool 2x2
- up-conv 2x2
- conv 1x1
Question ?
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Tools and Hardware

- Deep learning framework
  - Keras/Tensorflow, MXNet, Caffe/Caffe2, Chainer, PyTorch...
- GPU Servers from ITS chair
The final evaluation will be based on:

- Initial implementation / idea presentation, 10% (03.12.2018)
- Final presentation, 20% (04.02.2019)
- Report/Documentation, 12-18 pages (single column), 30% (until 28.02.2018)
- Implementation, 40% (until 28.02.2018)
- Participation in the seminar (bonus points)
Enroll on Doodle (link → HPI website of the course)
Starting time: 8 a.m. 19.10.2018 (Friday)
Maximum number of participants: 20
Literature

- Book: "Deep Learning", Ian Goodfellow, Yoshua Bengio and Aaron Courville, online version: www.deeplearningbook.org
- cs231n: Convolutional Neural Networks for Visual Recognition, course of Stanford University
- Deep Learning courses at Coursera, created by Andrew Ng and deeplearning.ai, MOOC
- Practical Deep Learning For Coders, created by fast.ai, MOOC
- “Deep Learning - The Straight Dope” http://gluon.mxnet.io, deep learning tutorials created by MXNet team
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Thank you for your Attention!

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